UCRL-JC-124384 Abs

Abstract for an Invited Paper
for the DPP96 Meeting of
The American Physical Society

Nonlinear Gyrokinetic Simulation of Transport in DIII-D with Sheared Rotation*

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We have performed 3D nonlinear toroidal gyrokinetic simulations of ion-temperature-gradient-driven (ITG) turbulence and transport in negative-central-shear (NCS) discharges in DIII-D. Our simulations include externally imposed toroidal velocity shear, as well as self-generated $\boldsymbol{E} \times \boldsymbol{B}$ flow shear, use equilibria reconstructed from experimental data by the EFIT, ENERGY and ONETWO codes, and are run for actual experimental parameters. Multiple simulation runs produce profiles of the ion thermal diffusivity and toroidal momentum diffusivity. The thermal diffusivities are found to be in general agreement with experiment in the inner half of the discharges studied, including the NCS transport barrier region. $\boldsymbol{E} \times \boldsymbol{B}$-flow-shear stabilization associated with the sheared toroidal rotation is found to play a key role in the NCS transport barrier. If we turn off the toroidal velocity shear in the simulations, then the transport barrier is absent. We will report details, including toroidal viscosity values, results for weak-negative-shear discharges, as well as results that address the role of impurity- and beam-ion populations. This work represents a significant extension beyond our earlier simulations of TFTR and similar plasmas[1] to strongly shaped noncircular finite-aspect-ratio equilibria. Our code has been benchmarked against linear calculations for DIII-D,[2] and against earlier linear and nonlinear circular cross-section results. The key ingredients of the simulation code will be described. Progress on and initial results from a new bounce-averaged drift-kinetic δf electron algorithm will also be reported.

*This work supported by US DOE at LLNL under contract W-7405-ENG-48, and at GA under contract CE-AC03-89ER51114, and by the Numerical Tokamak Turbulence Project.

**In collaboration with B.I. Cohen, L.L. Lao, D.E. Shumaker, B.W. Stallard, and T.J. Williams.

[1]A.M. Dimits, T.J. Williams, J.A. Byers, and B.I. Cohen, Phys. Rev. Lett. **77**, 71 (1996).

[2]G. Rewoldt, 1996, private communication.